WILLOW CREEK BASIN

ECONOMIC AND FINANCIAL ANALYSIS OF IRRIGATION DEVELOPMENT

ALBERTA ENVIRONMENT

PLANNING DIVISION

April 1986

MARV ANDERSON & ASSOCIATES LIMITED
ECONOMIC CONSULTANTS

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ECONOMIC CONSULTANTS

April 30, 1986

Mr. D. H. Younie,
Planning Division,
Alberta Environment,
9820-106 Street,
Edmonton, Alberta. T5K 2J6

Dear Mr. Younie:

It is a pleasure to submit to you our final report entitled: *Willow Creek Basin: Economic and Financial Analysis of Irrigation Development*, in accordance with Contract No. 86-0596.

As requested, this document is an economic and financial analysis of the feasibility of developing additional irrigation in the Willow Creek Basin if one of four potential storage sites was constructed.

We believe that the analysis herein should provide Alberta Environment with all the economic input required in the policy-making process.

Thank you for your continued support throughout the duration of this study. We look forward to the possibility of working with you again in the challenging months and years ahead.

Respectfully submitted,

MARV ANDERSON & ASSOCIATES LTD.

Marvin S. Anderson, P. Ag.

326 Vista Manor • Sherwood Park, Alberta T8A 4J7 • phone: (403) 464-4020

EXECUTIVE SUMMARY

THE OVERALL OBJECTIVE OF THIS STUDY WAS TO DETERMINE THE ECONOMIC AND FINANCIAL FEASIBILITY OF DEVELOPING ADDITIONAL STORAGE TO AUGMENT WATER SUPPLIES FOR IRRIGATED AGRICULTURE IN THE WILLOW CREEK BASIN. FOUR POTENTIAL WATER STORAGE OPTIONS WERE CONSIDERED. (TABLE 1)

THE STUDY FOCUSES EXCLUSIVELY ON THE ANTICIPATED BENEFITS TO AGRICULTURE.

FROM A PROVINCIAL PERSPECTIVE, THE BASIC EMPIRICAL RESULTS INDICATE THAT THE ECONOMIC BENEFIT-COST RATIO IS ABOUT 0.60 FOR ALL FOUR POTENTIAL RESERVOIR SITES WHILE THE SOCIO-ECONOMIC BENEFIT-COST RATIO (WHICH CONSIDERS "SPIN-OFFS" FROM AGRICULTURE) IS ABOUT 1.10. THE CORRESPONDING NET PRESENT VALUES ARE IN THE RANGE OF -$15 M TO -$20 M AND $4 M TO $8 M FOR THE ECONOMIC AND SOCIO-ECONOMIC ANALYSIS RESPECTIVELY. (TABLE 2)

UTILIZING ECONOMIC EFFICIENCY CRITERIA WITH RESPECT TO AGRICULTURE, THEREFORE, THE PRINCIPAL CONCLUSION OF THIS STUDY IS THAT ALL FOUR PROPOSED RESERVOIRS APPEAR TO BE EQUALLY POOR INVESTMENT OPPORTUNITIES.

IN ADDITION, SINCE THE NET RETURN TO FURTHER IRRIGATION DEVELOPMENT IN THE WILLOW CREEK BASIN WOULD MOST LIKELY BE VERY SIMILAR IRRESPECTIVE OF WHICH PROPOSED RESERVOIR SITE WAS SELECTED, IT IS NOT POSSIBLE TO DEFINITIVELY RANK THE RESPECTIVE RESERVOIRS IN TERMS OF THEIR ECONOMIC FEASIBILITY.

OTHER ANTICIPATED BENEFITS WOULD, HOWEVER, INCREASE THE BENEFIT-COST RATIOS AND RELATED NET PRESENT VALUES CALCULATED IN THIS REPORT. IF THE DIRECT NON-AGRICULTURAL NET BENEFITS ACTUALLY AVERAGED $1½ M - $2 M/ANNUM OVER A 30 YEAR PERIOD, EVEN THE PURELY ECONOMIC BENEFIT-

COST RATIOS WOULD EXCEED UNITY (AND THUS INDICATE ECONOMIC FEASIBILITY).

ON THE OTHER HAND, FROM A SOCIO-ECONOMIC PERSPECTIVE (WHICH CONSIDERS THE "SPIN-OFFS" FROM PROPOSED IRRIGATION DEVELOPMENT), ALL OF THE PROPOSED RESERVOIRS APPEAR TO BE VIABLE INVESTMENT OPPORTUNITIES IRRESPECTIVE OF ANY NET BENEFITS TO THE PROVINCE OTHER THAN THOSE GENERATED BY AGRICULTURE-RELATED ACTIVITIES. FURTHERMORE, IF THIS RATIONALE WAS VALID, WE WOULD ALSO TENTATIVELY CONCLUDE THAT THE OFFSTREAM PINE COULEE SITE WOULD MOST LIKELY GENERATE THE LARGEST TOTAL LONG-TERM NET BENEFIT TO THE PROVINCE.

FROM A REGIONAL PERSPECTIVE, SHORT-TERM CONSTRUCTION EXPENDITURES WOULD ALSO HAVE A GENERALLY POSITIVE ECONOMIC IMPACT ON LOCAL COMMUNITIES; AN INCOME INJECTION OF ABOUT $3 M FOR ANY ONE OF THE RESERVOIRS HERE CONSIDERED OVER A TWO YEAR PERIOD. BUT IN THE LONGER-TERM, THIS WOULD BE DWARFED BY THE SPIN-OFFS FROM MORE INTENSIVE AGRICULTURAL OPERATIONS AND RELATED ACTIVITY IN THE BASIN.

FINALLY, A BRIEF ASSESSMENT OF THE FINANCIAL IMPLICATIONS OF ON-FARM IRRIGATION DEVELOPMENT IN THE BASIN ILLUSTRATES HOW THIS IS LARGELY DEPENDENT UPON A FARMERS' PARTICULAR CIRCUMSTANCES. NEVERTHELESS, THIS SUPPLEMENTARY ANALYSIS DOES SUGGEST THAT IRRIGATED AGRICULTURE PRESENTLY HAS A COMPARATIVE ADVANTAGE OVER DRYLAND AGRICULTURE IN THE WILLOW CREEK BASIN.

Table 1

PROPOSED RESERVOIR CHARACTERISTICS

Proposed Reservoir Site	Location	Capacity (acre feet)	Capital Cost($M)	Irrigation Potential (acres)
1. Willow Creek #1 (Claresholm-Pulteney)	onstream	32,400	30.0	18,700
2. Pine Coulee #2	offstream	41,000	29.5	21,300
3. Willow Creek #2 (Junction)	onstream	59,200	35.5	25,000
4. Willow Creek #3 (Lane Creek)	onstream	47,800	31.25	20,000

Table 2

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC BENEFIT-COST RATIOS FOR AGRICULTURE*
WILLOW CREEK BASIN

Reservoir Site	ECONOMIC ANALYSIS			SOCIO-ECONOMIC ANALYSIS**		
	B/C	NPV($M)	Overall Assessment	B/C	NPV($M)	Overall Assessment
1. WC Site #1 (Claresholm-Pulteney)	0.58	(18.5)	Not feasible	1.09	3.8	Marginal
2. PC Site #2 (Pine Coulee - high)	0.63	(16.7)	Not feasible	1.17	7.8	Marginal
3. WC Site #2 (Junction - high)	0.59	(21.8)	Not feasible	1.11	5.6	Marginal
4. WC Site #3 (Lane Creek)	0.58	(19.2)	Not feasible	1.09	4.2	Marginal

*Total costs versus the net benefits to agriculture. Negative values indicated in brackets.

**Also considers provincial "spin-offs" from agriculture; particularly relevant to satisfy regional development objectives.

ACKNOWLEDGEMENTS

Numerous people have contributed greatly to the successful completion of this study.

In particular, the authors would like to thank the Willow Creek Local Volumteer Advisory Committee for the opportunity to meet with them during the course of this study. The personal assistance of Mr. Doug Leeds, Mr. Don Glimsdale, Mrs. Myrna Glimsdale, and Mr. Duane Southgate was particularly helpful.

Personel in Alberta Environment have also been very supportive throughout the preparation of this report: These people include, in particular: Mr. Doug Younie (Edmonton), and Mr. Lorand Szojka, Mr. John Carlson, and Ms. Wendy Procyshen (Lethbridge).

In the final analysis, however, all errors or omissions which remain are the responsibility of the authors.

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1. INTRODUCTION

1.1 Background

Willow Creek and its tributaries make up the Willow Creek Basin. The Basin drains from the Porcupine Hills and covers an east-west area between Highway #2 and the Rocky Mountain Forest Reserve. It consists of about 24 townships; some 864 square miles (2,200 km^2). North-south, the Basin lies betwen Nanton and Fort MacLeod. (Figure 1.1)

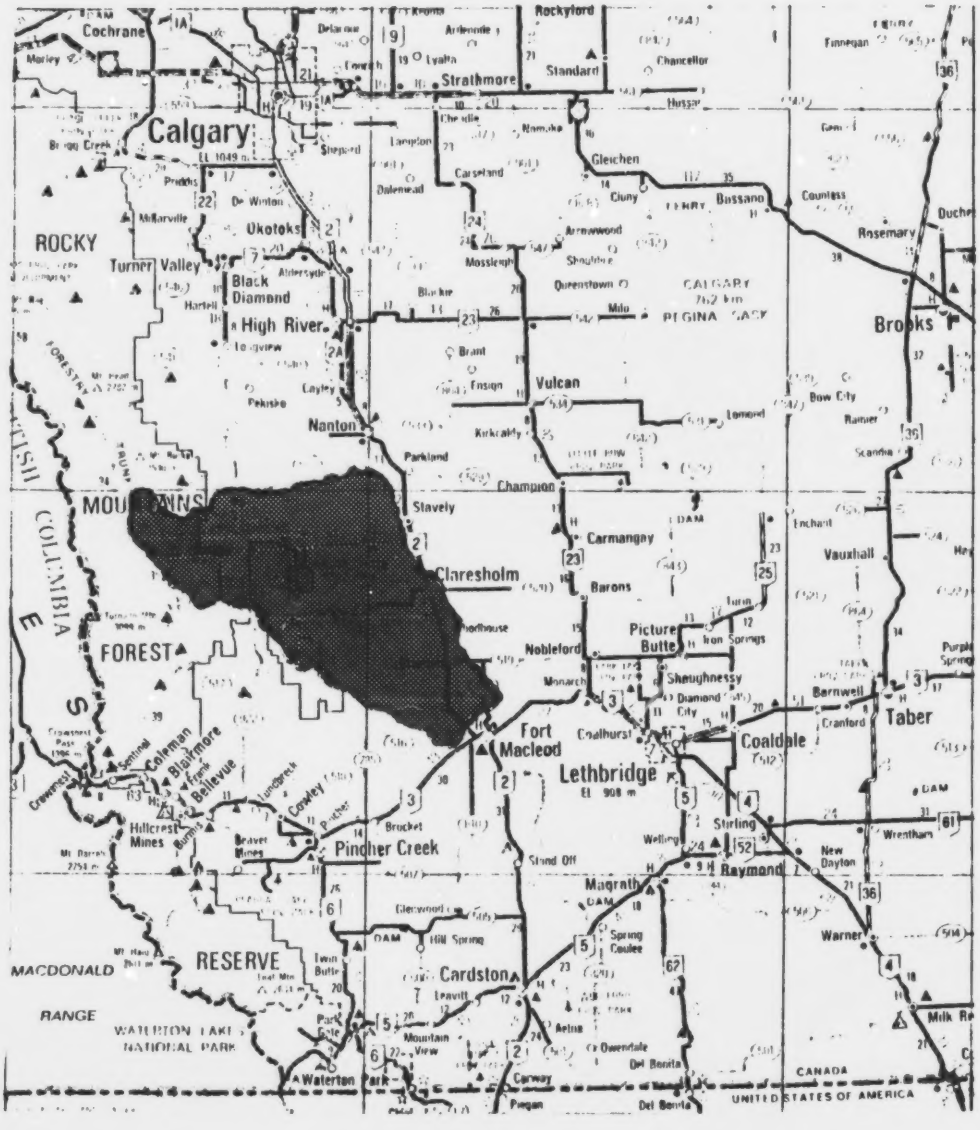
The 5th Meridian roughly divides the Basin into a western forestry zone and an eastern agricultural zone. The agricultural zone is characterized by ranching to the west of Willow Creek and dryland farming to the east of the creek and adjacent to Highway #2.

Ways to maintain water flows and reduce periodic flooding in the region were initially investigated in the late 1950's and this led to the construction of the Chain Lakes Reservoir in the upper end of the Basin. On its completion in 1962 the reservoir's 17,000 acre foot capacity was more than adequate to meet the then current recreational, municipal and agricultural demands placed on it.

Water demands, however, have grown greatly since then. Increased irrigation needs, along with growing municipal requirements and the need to provide a secure water supply for the communities along Willow Creek now exceed the storage capacity of Chain Lakes. Licensed irrigation in the region is already some 5,800 acres, despite a current moritorium on more irrigation development. The 1982 freeze-up of Willow Creek and droughts in the summers of 1984 and 1985 - the worst in 65 years - underlined the current water supply-demand imbalance in the area. In both 1984 and 1985

Figure 1.1

LOCATION OF THE WILLOW CREEK BASIN



the limited Chain Lakes water supply had to be earmarked for high priority uses such as municipal use and livestock watering. Because of this, all licensed irrigation use was cut off early in July/84 and June/85 respectively. This had a very serious negative impact on local farmers and the local economy in general. Dryland crops were extremely poor.

To effectively respond to this growing problem, Alberta Environment initiated a preliminary study of the situation in 1982. Thereafter, various technical studies proposed and evaluated alternative water management options for the region. These studies are now nearing completion.

1.2 Present Study Objectives

The overall objective of this particular study is to determine the *economic* and *financial* feasibility of developing additional storage to augment water supplies for agriculture in the Willow Creek Basin.

The four alternative sites to be considered are:

1. Willow Creek Site #1(Claresholm-Pulteney)
2. Pine Coulee Site #2 - High (offstream)
3. Willow Creek Site #2 - High (Junction)
4. Willow Creek Site #3 (Lane Creek/Kuntz Creek)

The specific terms of Reference are provided in Appendix A.

1.3 Study Methodology

This analysis focuses exclusively on the anticipated benefits and costs to agriculture.

The basic methodology utilized is discounted cash flow analysis, a methodology which traces all the tangible incremental costs and benefits of a project over time, adjusts future dollars to the present (by using the inverse of an interest rate), and then compares the cumulative value of the projected benefit stream with the cumulative value of the anticipated cost stream. Thus:

$$B/C = \frac{\text{Sum of Discounted Tangible Incremental Benefits}}{\text{Sum of Discounted Tangible Incremental Costs}}$$

$$NPV = \text{Sum of Discounted Tangible Incremental Benefits } \textit{minus} \text{ Sum of Discounted Tangible Incremental Costs}$$

To be economically or financially feasible, the Benefit-Cost Ratio (B/C) must exceed 1.0, and the Net Present Value (NPV) must be positive.

This assessment is conducted from three different perspectives or accounting stances: farmers, the region, and the province.

1.4 Study Outline

The following study adheres closely to the study objectives and the logic underlying the study methodology:

Section 2 - Cost Estimates

Section 3 - Benefit Estimates

Section 4 - Economic Analysis

Section 5 - Farm Financial Analysis

Section 6 - Summary and Conclusions

Background agricultural cost and production data, the basic economic benefit-cost simulations, and a brief statistical profile of agricultural producers in MD #26 (Willow Creek) are also appended.

2. COST ESTIMATES

2.1 Introduction

The purpose of this section is to summarize all of the estimated incremental capital and operating costs associated with the various water storage/delivery alternatives. These include: (a) reservoir costs; (b) off-farm delivery costs; and (c) on-farm system costs. Incremental on-farm production costs and indirect non-farm costs are considered in Section 3.

2.2 Reservoir Costs

Estimated capital costs for alternative reservoirs are summarized in Table 2.1 (Also see Figure 2.1.) They range between 29 and 36 million (1985) dollars.

These expenditures are expected to arise over a two year construction period; 40 percent of the total cost in Year 1 and 60 percent in Year 2.

In addition, and regardless of the reservoir constructed, annual operating and maintenance costs associated with the reservoir are estimated to amount to about 2 percent of the respective initial capital costs per annum.

Table 2.1

ESTIMATED CAPITAL COSTS FOR ALTERNATIVE STORAGE SITES
WILLOW CREEK BASIN
($1985 Million)

Proposed Reservoir Site	Reservoir Capacity (acre ft.)	Capital Cost Estimates*
1. Willow Creek Site #1(Claresholm-Pulteney)	32,400	30.00 (24M)**
2. Pine Coulee Site #2 - High (offstream)	41,000	29.50 (27.5M)
3. Willow Creek Site #2 - High (Junction)	59,200	35.50 (25M)
4. Willow Creek Site #3 (Lane Creek/Kuntz Creek)	47,800	31.25 (25M)**

*Includes structural construction, land, related costs (utility and road relocations) and contingencies. Excludes engineering costs (typically 15% of basic costs) and the costs of building relocation or purchase.

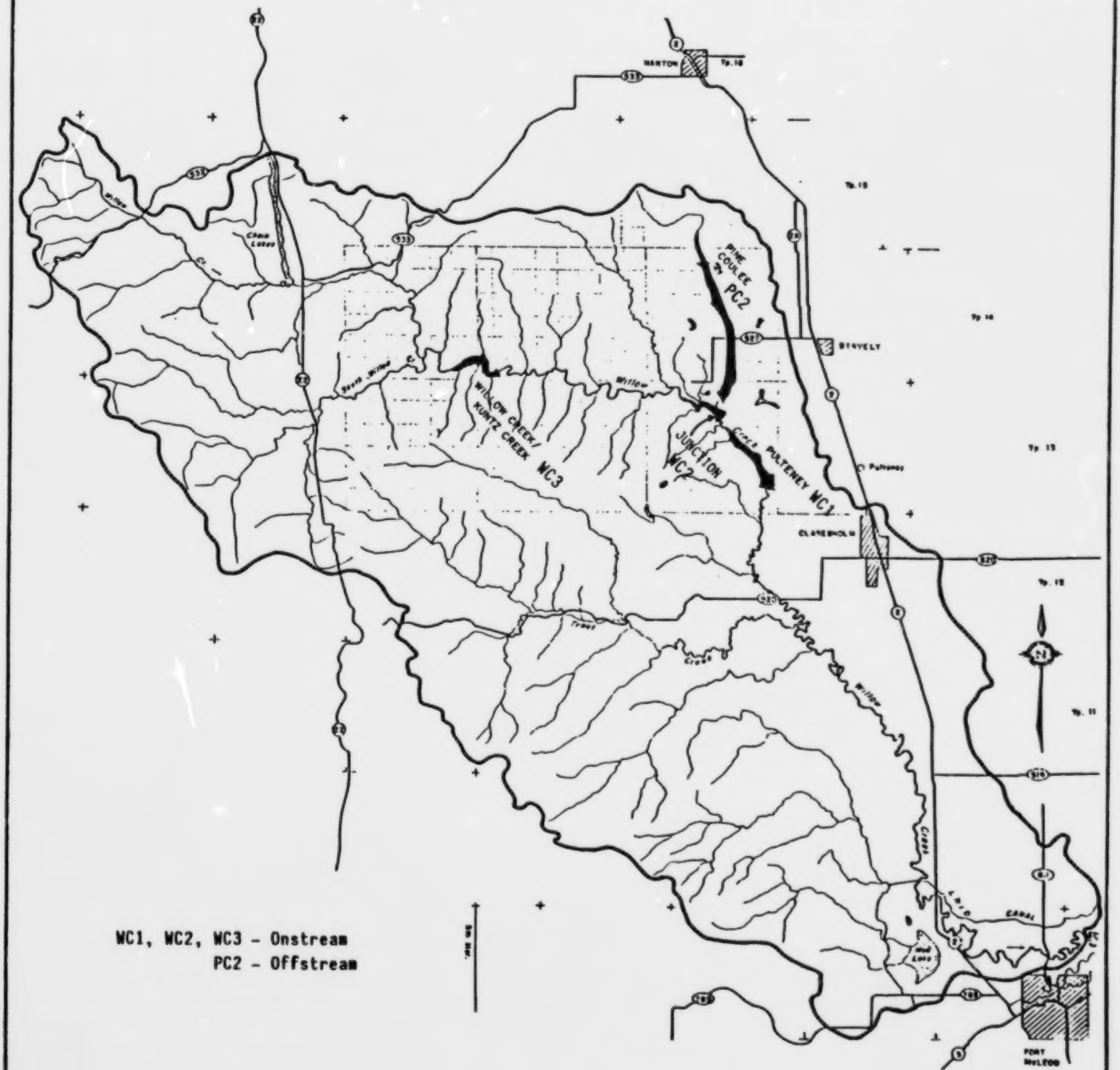
**The conceptual design costs for WC #1 and WC #3 are $24M and $25M respectively. These are inflated to make the costs approximately comparable to PC #2 and WC #2 costs. That is: feasibility level costs = 1.24 x conceptual design cost estimates. The rationale for this procedure is provided in the Local Volunteer Advisory Committee Minutes, November 28, 1985, p. 9.

Sources: (1) Alberta Environment/Design and Construction Division, *Willow Creek Feasibility Studies - Conceptual Designs and Cost Estimates*, Lethbridge, August 1985.

(2) Personal communications with Alberta Environment/Planning Division, Lethbridge, March 1986.

Figure 2.1

POTENTIAL DAMSITES IN THE WILLOW CREEK BASIN



2.3 Delivery System Costs

All anticipated irrigation development in the Willow Creek Basin is expected to be contiguous to either the proposed reservoir or the Creek itself.[1] Farmers would pump directly from these water sources by using underground or above-ground pipe and pump systems. This would be installed by the farmers and paid for by the farmers. The maintenance costs associated with this option would be negligible. Nor would there be any off-farm operating costs which are characteristic of most off-farm systems, i.e. typical annual Irrigation District costs.

Initial capital costs (to the farmer) are, however, dependent upon how far the water must be pumped, pumping infrastructure due to elevations, and how the on-farm system is designed. For two existing irrigation farmers adjacent to the creek, a used above-ground pipe system for about one-half mile cost approximately:

$$\frac{\$11,000}{3,000 \text{ ft.}} \simeq \$3.70/\text{foot}$$

This involves 6", 7", and 10" steel pipe and each of these options deliver water to wheel roll units which irrigate 108 and 140 acres respectively. This translates into a capital cost of, say, $75-$100 per irrigated acre.

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[1] It is estimated that there is 26,200 acres within 1.8 miles (3 km.) of the creek and 5,800 acres of existing sprinkler systems in the Basin, for a net potential of 20,400 acres. (Alberta Agriculture/ Project Planning Branch, *Irrigation Feasibility in the Willow Creek Basin*, Lethbridge, August 1985.) A new reservoir would allow for the development of between 18,700 acres and 25,000 acres of additional irrigation. (See Section 3.)

Another irrigation farmer in the region services a center pivot using buried PVC pipe. These PVC costs (installed) are approximately:

12"	$8.00/foot
10"	5.21/foot
8"	3.51/foot

Depending upon the various possible delivery configurations and pipe sizes required, the total capital cost/acre for this type of system (serving either one or two pivots) can vary considerably:[1]

Adjacent -	
½ mi.	$ 80-140/acre
1 mi.	$132-264/acre
1½ mi.	$184-368/acre

We expect, however, that typical capital costs ($1985) could reasonably be expected to *average:*

Adjacent -	
½ mi.	$100/acre
1 mi.	$175/acre
>1 mi.	$225/acre

The simulations conducted following employ these estimated unit costs. In addition, it is anticipated that the maximum potential acreage which could still be irrigated in the Basin for each

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[1] Based on 132 acres per center pivot.

respective distance from the creek/reservoir is as follows:

Distance	Total [1]	Existing [2]	Additional Potential
adjacent	5,200	2,000	3,200
½ mile	6,700	2,000	4,700
1 mile	8,400	1,800	6,600
> 1 mile	residual	-	residual
		5,800	

It is further assumed that the land closest to the creek/reservoir would be irrigated first. This scenario would mean that over time average unit delivery costs for the whole Basin would climb.

2.4 Sprinkler System Costs

Based upon historical trends in Southern Alberta and recent discussions with Basin farmers, on-farm sprinkler systems are expected to be predominately center pivots and wheel rolls. Perhaps 2/3rds will be center pivots; about 1/3rd will probably be wheel rolls.

Center pivots can be installed for approximately $60,000 per unit,

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[1] Alberta Agriculture/Project Planning Branch, *Irrigation Feasibility in the Willow Creek Basin*, Lethbridge, August 1985.

[2] Authors estimates.

as suggested following:

Center Pivot (new)	$35,000
Waterlines/drops	7,000
Powerline/rotophase	5,500
Natural gas installation . .	2,000
Pump and Motor	10,000
TOTAL	$59,500

For 132 acres, this amounts to about $450/acre.

On the other hand, a used wheel-roll might be expected to cost approximately:[1]

	Case 1 (108 acres)	Case 2 (140 acres)
Wheel Moves (used)	12,750	12,000
Pump	8,900 (new)	5,000 (used)
Gas	2,000	2,000
Other	-	2,500
TOTAL	23,650	21,500
Per Acre	$219/acre	$153/acre

These estimates are generally consistent with the estimated capital costs as indicated in accompanying Table 2.2. This would suggest

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[1] These estimates are also based on actual installations in the Basin. March 1986.

Table 2.2

COST ESTIMATES FOR ALTERNATIVE ON-FARM IRRIGATION SYSTEMS

SYSTEMS	TOTAL CAPITAL COST PER ACRE*	DOLLARS PER IRRIGATED ACRE PER YEAR						
		COST OF LABOR*	MAINTENANCE AND REPAIRS*	FUEL COSTS BY ENERGY TYPE				
				Electricity A	Electricity B	N. Gas	Diesel	LPG
WHEEL-ROLL (2 laterals per ¼ section, 8 hr. sets)	240	6.79	2.48	19.16	15.39	10.34	27.76	28.34
WHEEL-ROLL (4 laterals per ¼ section, 12 hr. sets)	363	6.30	4.78	21.88	15.15	9.83	26.34	26.88
STATIONARY CENTER Pivot (¼ mi. long)								
A) 70 psi @ pivot	502	2.12	7.32	23.15	16.98	11.22	29.96	30.58
B) 45 psi @ pivot	474	2.12	7.17	16.63	12.19	8.23	21.52	21.97
STATIONARY PIVOT (85 psi ½ mi. long)	379	0.90	4.64	24.86	18.77	11.98	33.37	34.06
TOWABLE CENTER PIVOT (¼ mi. long)								
A) 70 psi @ pivot	336	3.60	4.76	21.06	17.09	11.25	30.90	31.54
B) 50 psi @ pivot	298	3.60	4.64	15.35	12.45	8.28	22.52	22.99
HARD-HOSE TRAVELER (Reel Irrigator)	473	4.23	5.22	35.01	27.51	17.99	49.38	50.41
BORDER DYKES	359	7.21	2.49	-	-	-	-	-
GATED PIPE (Gravity)	482	6.31	3.61	-	-	-	-	-
GATED PIPE (Pump @ 10 psi)	488	8.10	3.70	3.25	2.21	1.85	3.81	3.89

ASSUMPTIONS:

Water available at the edge of field
12" net water applied per year
180 acres irrigated by wheel rolls and surface methods
132 acres irrigated by 1/4 mile pivot
500 acres irrigated by 1/2 mile pivot
Cost of installing electric or natural gas lines not included
Annual water rates ($10-15 per acre) not included

UNIT COSTS: **

Natural gas (GJ)	2.70
Propane (L)	0.24
Diesel (L)	0.41
Labor ($/hr)	8.00

*Averages for all fuel types.
**Rebates included in final calculations.

Source: Alberta Agriculture/Irrigation Division, Lethbridge, 1986.

a typical average unit cost for the Basin for both center pivots and wheel moves of, say: (1985 Dollars)

$$(2/3)(\$450) + (1/3)(\$200) = \underline{\$367}/\text{acre}$$

In the simulations which follow, this unit cost begins in Year 3.

In addition, there are annual operating and maintenance costs which depend on how far the center pivot or wheel move is from the water source and what lift is involved:[1] ($/acre/year)

Distance	Lift					
	25'	50'	75'	100'	150'	250'
Adjacent	23	24	26	28	34	41
½ mile	25	27	28	29	35	42
1 mile	26	28	29	31	37	44
1½ miles	28	30	31	32	39	46

Out of these annual totals, about $4.00/year would be required for equipment maintenance while the remainder would consist of annual expenditures on fuel and for electricity.

[1]For a ¼ mile pivot on a ¼ section for a 10" net application per year. See: Alberta Agriculture/Project Planning Branch, *Irrigation Feasibility in the Willow Creek Basin*, Lethbridge, August 1985.

In the Willow Creek Basin, the lift is about 125' at the upper end; perhaps as little as 25' at the lower (south) end. The lift would be very small around any of the proposed reservoirs. For the whole Basin, a lift of 50' would most likely be typical. This is then adjusted downward $4.00/acre to recognize the lower O & M costs for wheel moves.

Again assuming that the closest land is developed first, the larger the area developed the more likely average region-wide operation and maintenance costs would rise.

Operating and maintenance costs would also commence in Year 3, climbing annually until the land was fully developed.

3. NET BENEFIT ESTIMATES

3.1 Introduction

The expected net benefits of irrigation are here considered with respect to: (a) crop production; (b) livestock productivity and stockwatering; (c) local construction expenditures; (d) indirect benefits; and (e) other impacts.

3.2 Crop Production

The net income of farm operators from farm production is a mixture of rent from the use of land, labor income from self-employment, property income from the buildings and machinery, and a return to entrepreneurship and risk-taking. This is approximated here by calculating the average net value added for regional crop production, with and without irrigation, and then estimating the net difference. That is:

	Revenue	Costs	Difference
With Project (Irrigation)	R	C	I
Without Project (Dryland)	R'	C'	I'
	R"	C"	I"

where R, C and I are gross revenue, costs, and income (or value-added) respectively.

Irrigation

Hydrology simulations indicate that the proposed reservoirs would allow for additional irrigation of between 18,700 and 25,000 acres,

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depending upon the water management option selected. The respective acreages are indicated in accompanying Table 3.1. In addition, for the economic simulations which follow it is further assumed that this potential irrigation will be developed at the rate of about 2,500 acres per year, beginning when construction of the reservoir is initiated, i.e., Year 1. This is consistent with local farmer expectations.

Table 3.1

ADDITIONAL POTENTIAL IRRIGATION IN THE WILLOW CREEK BASIN FOR ALTERNATIVE RESERVOIR DEVELOPMENT PROPOSALS

Proposed Reservoir Site	Live Storage (acre-feet)	Additional Potential Irrigation (acres)*
1. Willow Creek Site #1 (Claresholm-Pulteney)	28,000	18,700
2. Pine Coulee Site #2 - High (offstream)	32,000	21,300
3. Willow Creek Site #2 - High (Junction)	37,500	25,000
4. Willow Creek Site #3 (Lane Creek/Kuntz Creek)	30,000	20,000

*Live storage ÷ 1.5. Assumes that regulated flows with a reservoir would not affect the existing irrigated acreage.

In every case the total potential acreage irrigable is constrained by the available water supply; not potentially irrigable land. There are only about 28,400 acres of potentially irrigable land in the Basin within three kilometers of the creek/reservoir and another 53,000 acres which could be served if lateral systems were also

constructed. At project maturity, if water supplies in the Basin still actually exceeded total water demand without the Basin, this "excess" water would most likely be used to satisfy other outstanding water requirements in lower portions of the Oldman River Basin.

Precisely which crops would be produced under irrigation in the future is difficult to predict. On the basis of existing irrigated cropping patterns and discussions with local farmers, however, we expect an even stronger crop-livestock interdependency to evolve in the future. (Table 3.2)

Table 3.2

PROJECTED CROP MIX WITH IRRIGATION

Crop	CD #3*	Local Farmer Expectations**	CONCENSUS
Wheat***	19.1	10-35	25
Oat Silage Barley Silage }	3.5	10-15	10
Barley Grain	18.1	10-20	10
Canola/Other	1.4	0-5	5
Hay (incl. alfalfa)	34.1	20-65	45
Other	23.8	5	5
TOTAL	100.0%		100%

*Statistics Canada, *Census of Agriculture, Alberta, 1981*, Ottawa, 1982.

**From discussions with local farmers.

***Mostly soft white wheat but includes some winter wheat.

Projected crop yields under irrigation have been taken from previous studies[1] and recent discussions with local farmers.

The economic (long-term) price projections are assumed to be similar to prices during 1972-84, all expressed in terms of $ 1985. The financial prices are approximately equivalent to 90 percent of actual prices in 1984. Reflecting the current downturn in agricultural product prices, the financial price projections are generally lower than the longer-term economic price projections.

Resulting crop revenue projections with irrigation are summarized in Appendix Table B-1.

Related costs of production for irrigated crops are summarized in Appendix Table B-2. These tabulations indicate that the estimated average net value-added (income) or a per-acre basis should be about:

	Financial	Economic
Gross Revenue	$305	$321
Production Costs	196	193
Net Value Added	$109	$128

[1]Alberta Agriculture, *Irrigation Water Requirements in the South Saskatchewan River Basin: Economic Analysis Component*, Edmonton 1983.

Dryland

Similar calculations were conducted for the existing dryland crop production which would be replaced with the proposed irrigation. (Appendix Tables B-3/B-4)

In this case, the projected crop mix reflects both current cropping patterns in Census Division #3 and local farmer expectations, as indicated in Table 3.3 following.

Table 3.3

PROJECTED CROP MIX WITH DRYLAND

Crop	CD #3*	Local Farmer Expectations**	CONCENSUS
IMPROVED			
Wheat***	20.4	30-40	25
Barley	28.0	40-45	35
Oats	2.3	0-5	3
Canola/Other	1.4	0-5	2
Hay/Other	13.2	5-10	10
Improved Pasture	12.7	0-10	5
Summerfallow	10.4	10	10
Other	1.6	-	-
UNIMPROVED	10.0	10	10
TOTAL	100.0%		100%

*Statistics Canada, *Census of Agriculture, Alberta, 1981*, Ottawa, 1982. Adjusted such that the improved land = 90 percent of the total land.

**From discussions with local farmers.

***Mostly hard spring wheat but includes some duram and some winter wheat.

Expected yields are generally linear extrapolations based on regional data for the period 1974-83. The price projections are identical to expected product prices with irrigation (see above).

Current dryland costs-of-production again exclude all payments to land labor, management, and capital such that all residual revenues represent a composite value-added; income payable to the respective factors-of-production

These estimates indicate that the average net value-added (income) for dryland crop production in the Willow Creek Basin is probably about: (per acre)

	Financial	Economic
Gross Revenue	$69	$79
Production Costs	50	48
Net Value Added	$19	$31

This is representative of all dryland; improved (cultivated) and unimproved.

Crop Summary

The focus of this study, however, is on the *difference* in the per acre income from crop production with and without irrigation in the Basin. Thus, our calculations suggest that in this regard this difference should *average*, in constant 1985 dollars, approximately:

	Financial	Economic
NVA Irrigation	$109	$128
NVA Dryland	19	31
Difference	$ 90	$ 97

This value-added (or income) difference is further assumed to remain constant over the 30 year life of the project (in $ 1985). This essentially assumes (for both irrigation and dryland):

> Any real gross revenue increase (or real unit cost decrease) will be exactly offset by a real unit cost increase (or real gross revenue decrease) or vice versa via technological change, better management, economies of scale, crop mix changes, etc.

This is illustrated in Figure 3.1.

3.3 Livestock Production and Stockwatering

An integral part of primary agricultural production in the Willow Creek Basin is livestock, particularly beef production. Indeed, livestock is often referred to as the most important "specialty crop" in the whole of Southern Alberta.

And here again, particularly since the publication of the *1981 Census of Agriculture*, it has become abundantly clear that irrigation also facilitates the integrated development of a much more intensive livestock sector. What is difficult is to accurately measure the relative extent of this livestock-crop interdependency.

This study first employs two independent methodologies[1] to estimate this potential income change in the livestock industry which can be traced to irrigation in Census Division 3.

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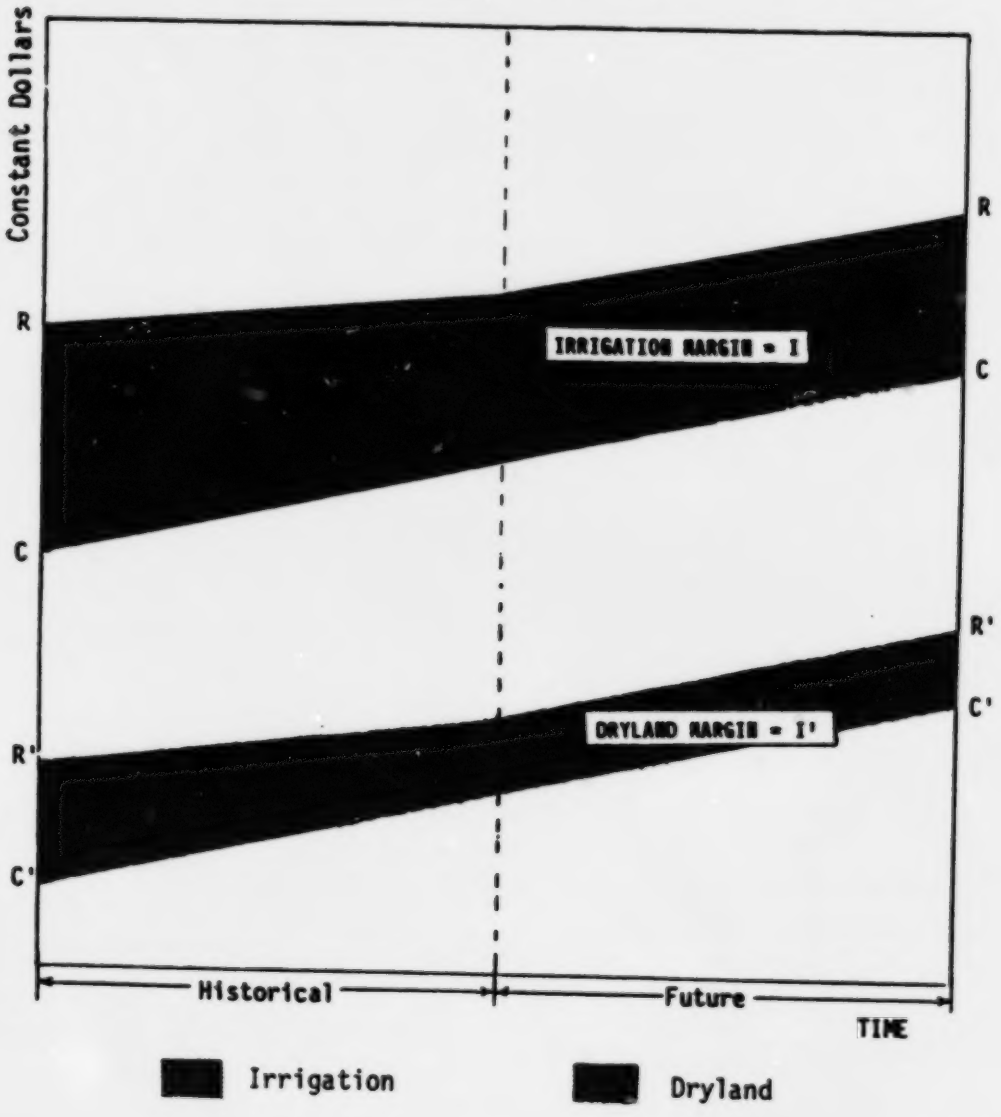
[1]A third approach using multipliers is illustrated in earlier studies by the same author. See MAA, *Oldman River Study*, Phase II, 1978; and *Milk River Study*, Part II, 1981.

Figure 3.1

PROJECTED SCENARIO ASSUMING A CONSTANT INCREMENTAL MARGIN I-I'= I° ($ Constant)



Methodology 1:

1. For both irrigation farms and dryland farms, calculate livestock numbers, grain consumption by livestock on these respective farms, and thus its market value;

2. Assume a 25 percent markup on the value of grain forage and pasture consumed by livestock in the region and then translate this into a per-acre incremental income estimate for the entire livestock sector, and then

3. Calculate the net difference between irrigation and dryland.

For CD #3, this is estimated to amount to the following:[1] ($ 1985 per acre)

	Financial	Economic
NVA Irrigation	$65.42	$68.99
NVA Dryland	4.96	6.32
Change in Value Added	$60.46	$62.67

[1]Detailed budgets are available from the author upon request.

Methodology 2:

1. Estimate the gross revenue per acre from livestock production for both irrigation and dryland in the region; and

2. Assume the net value-added (income) per acre from livestock production is 25 percent of gross revenue; and then

3. Calculate the net difference between irrigation and drylands.

In this case, the estimates are:

	Gross Revenue/Acre	Value Added
Irrigation	$268.16	$67.04
Dryland	37.07	9.27
Change in Value Added		$57.77

For CD #3 as a whole, therefore, a value of about $60/acre appears to be a fairly reliable estimate of the incremental income gain from livestock which could be attributed to more irrigation in the region. For the Willow Creek basin in particular, we conservatively estimate that this net incremental benefit should amount to at least $50/acre irrigated.

3.5 Local Construction Expenditures

Short-term benefits also accrue to the *region* through the payment of salaries and wages to local construction personnel, plus the purchase of some local construction materials for the proposed project.

To calculate these benefits, it is estimated that:[1]

- Disposable income will represent about 75 percent of total regional labor construction costs and perhaps one-quarter of this disposable income will be spent within the study area and towns in the immediate vicinity (Nanton, Stavely, Claresholm and Fort MacLeod).

- About 10 percent of total capital costs (less labor) will represent materials purchased within this same study area, while the net value-added associated with these materials will be about 25 percent.

In addition, the respective material-labor expenditure ratio for the reservoir is estimated to be approximately 60 percent materials/ 40 percent labor.

With these data and the expenditure patterns already detailed (Sections 2.2 and 2.4), an estimate of the direct benefit of local construction expenditures to the region can be generated.

Although this may be very significant to the region, these short-term benefits are not considered a net benefit to the province.

3.6 Indirect Benefits and Costs

When an industry (in this case agriculture) increases its output, it must also obtain more inputs which are provided by other industries. This ripple-effect is termed a *backward linkage*. In addition, this same increase in output dictates an expansion in related industrial processing capacity. This is a *forward linkage*. In

[1]This methodology was originally developed in: Marv Anderson & Assoc., *Oldman River Basin Study, Phase II, Economic Analysis of Water Supply Alternatives*, Alberta Environment, Lethbridge, April 1978.

turn, the expansion of these other industries means increased demands are placed on their suppliers, and so on through a chain of interdependent industries. In total, this is referred to as the industry effect. In addition, as industries increase their production, they increase staff and thus pay more in wages. This increased income generates additional consumption and subsequent resulting increases in industry outputs. This is referred to as the income effect.

A closed input-output model generates total multipliers which capture both the industry and income effects by treating "households" as just another industry.

Increased demand (output) can, however, be met by either Alberta industry produced goods (i.e., domestic production), or imports, withdrawals from inventory, or government. These latter three services are referred to as leakages from domestic production (i.e., demand which is met by other than Alberta industry produced goods) and to the extent these sources supplant domestic production in the supply of a commodity, the impact of an increase in final demand on domestic industries will be reduced.

The appropriate multipliers to employ to quantify the indirect net benefits of project implementation are therefore total ratio-form multipliers, with leakages, which are directly applicable to the value-added estimates calculated in Sections 3.2 and 3.3. These are provided in Table 3.4.

The specific multiplier of interest is 1.868. That is to say, for every $1 increase in the value-added of agriculture, another 87 cents in wages, salaries, and profits would also accrue to other Alberta industry.

Table 3.4

TOTAL MULTIPLIERS IN ALBERTA
(RATIO FORM, WITH LEAKAGES) BY MAJOR INDUSTRY, 1974

INDUSTRY	G.D.P. AT FACTOR COST*	GROSS OUTPUT
1. Agriculture	1.868	2.941
2. Forestry	2.855	3.221
3. Fishing, Hunting and Trapping	1.502	2.610
4. Mines, Quarries and Oil Wells	1.803	2.144
5. Manufacturing	3.315	2.827
6. Construction	2.318	2.654
7. Wholesale and Retail Trade	1.889	3.001
8. Transportation and Storage	2.143	2.816
9. Communications	1.624	2.558
10. Utilities	1.569	2.473
11. Finance, Insurance and Real Estate	1.490	2.147
12. Comm., Bus. and Personal Services	1.865	2.928

*Gross Domestic Product is approximately equal to Net Value Added.

Source: Alberta Treasury/Bureau of Statistics, *Economic Multipliers for Alberta Industries and Commodities*, Edmonton, March 1984, Table 4, p. 22.

This is the multiplier employed in the simulations which follow to calculate the respective socio-economic benefit-cost ratios for the province.

The inclusion of indirect (secondary) benefits and costs in this analysis is contingent upon the availability of unemployed resources such that expanding output in one region (or sector) would not imply a similar output reduction in another region (or sector).

In any case, the inclusion of indirect benefits in the economic analysis is most applicable when the decision-maker simply wants to know the general magnitude of the *total* benefits and costs which would arise from a proposed project, *assuming* that a decision has already been made to invest $X in Sector Y in Region Z. A strong case can be made for excluding indirect benefits from a provincial analysis which is deciding between two or more investment opportunities. In this situation, it is argued that the indirect benefits and costs would be similar irrespective of what project was considered and, therefore, largely irrelevant in the decision-making process.

3.7 Other Impacts

This study only quantifies the anticipated net benefits to the province of additional irrigation in the Willow Creek basin. Nevertheless, a number of other very real impacts are anticipated, as summarized in accompanying Table 3.5.

Table 3.5

THE ENVIRONMENTAL AND SOCIOLOGICAL IMPACT OF ALTERNATIVE RESERVOIR SITES

CRITERIA	ALTERNATIVE RESERVOIR SITES			
	WILLOW CREEK SITE 1	WILLOW CREEK SITE 2 HIGH	PINE COULEE SITE 2 HIGH	WILLOW CREEK SITE 3
ENVIRONMENTAL IMPACT				
Groundwater	Not studied, seepage could be substantial.	Not studied, seepage could be substantial.	Seepage acceptable, impact on wells is minimal. Require monitoring and mitigating measures to control seepage.	Not studied, seepage could be substantial.
Water Quality	No Concern (1)	Moderate Impact (2)	Moderate Impact (2)	No Concern (1)
Fish	Locally Detrimental (3)	Moderate Impact (2)	Summer and Winter Improvement (1)	Locally Detrimental (3)
Wildlife	Moderate Impact (2)	Moderate Impact (2)	Low Impact (1)	Serious Impact (3)
Parks and Lands	Moderate Impact (2)	Serious Impact on Park Area (3)	Enhances Existing Park Facility (1)	Impact on Valley (3)
Historic Sites	Serious Impact (3)	Moderate Impact (2)	Low Impact (1)	Serious Impact (3)
SOCIOLOGICAL IMPACT				
Number of People Seriously Affected	20	8	13	N/A
Number of Residences Lost	5	2	3	2
Number of Buildings Lost	16	10	14	N/A
Number of Improvements Lost	35	60	61	N/A
Least Preferred Site	7	4	1	8
Most Preferred Site	3	7	8	0
OVERALL RANKING				
Environmental	2	2	1	3
Sociological	3	2	1	3

Source: Personal correspondence with Alberta Environment/Planning Division, Lethbridge, March 1986.

Aside from these considerations, there are at least three major non-agricultural benefits of another reservoir in the Basin:

1. It would guarantee water supplies for Stavely, Claresholm and Granum and for municipal and industrial use. Some sites may also introduce the opportunity to have a gravity pressurized system and eliminate pumping costs.

2. It would increase the number of water-based recreation options available to the region. This could include some cottage development adjacent to the reservoir. And

3. It would serve as a water source to help control surrounding forest and grassland fires.

In general, it would allow for improved water management in the region and ultimately compliment existing operations in the upstream Chain Lake Reservoir. More stable and more secure water supplies ultimately translate into numerous socio-economic benefits for both the region and the province.

Clearly, the final decision-making process must consider all of the benefits and costs, both for agriculture and non-agriculture.

4. ECONOMIC ANALYSIS

4.1 Introduction

The purpose of this section is to compare the anticipated direct and indirect benefits of irrigation in the Willow Creek Basin with the offsetting direct and indirect costs.

The analysis following does not quantify related non-agricultural benefits or costs.

4.2 Methodology

Discounted cash flow analysis is used to generate two decision-making criteria: a *benefit-cost ratio* and a *net present value*.

$$B/C = \frac{\text{Sum of Discounted Tangible Incremental Benefits}}{\text{Sum of Discounted Tangible Incremental Costs}}$$

$$NPV = \text{Sum of Discounted Tangible Incremental Benefits } \textit{minus} \text{ Sum of Discounted Tangible Incremental Costs}$$

To be economically feasible, the Benefit-Cost Ratio (B/C) must exceed 1.0, and the Net Present Value (NPV) must be positive.

The analysis is also conducted from two different accounting stances: a provincial stance and a regional stance. And, in turn, each of these accounting stances has both an *economic* and *socio-economic* perspective.

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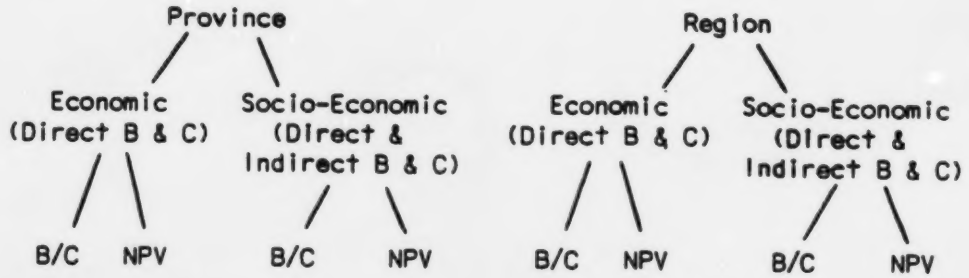

Here defined, the *economic* perspective only looks at direct benefits and costs while the *socio-economic* perspective considers both direct and indirect benefits and costs.

More specifically, the provincial economic benefit-cost ratio is defined as follows:

$$\text{Provincial Economic B/C} = \frac{\text{GDB} - \text{AC}}{\text{TPC}} = \frac{\text{NDB}}{\text{TPC}}$$

where: GDB = gross direct benefits,
AC = associated costs,
NDB = net direct benefits,
TPC = total project costs.

$$\text{Provincial Socio-Economic B/C} = \frac{(\text{GDB}-\text{AC}) + \text{GIB}-\text{GIC})}{\text{TPC}} = \frac{\text{NDB} + \text{NIB}}{\text{TPC}}$$

where: NDB = net direct benefits,
NIB = net indirect benefits (province),
GDB = gross direct benefits,
AC = associated costs,
GIB = gross indirect benefits (province),
GIC = gross indirect costs (province), and
TPC = total project costs

Each of these ratios has its regional counterpart which is defined in an exactly analogous manner except that the regional socio-economic B/C also considers local short-term construction impacts.

4.3 Related Parameters

The cash flow analysis conducted following also relies on a number of underlying parameters. These are:

Prices:	Real constant 1985 dollars
Time-Frame:	30 years
(Real) Discount Rate:	7%

To eliminate the problem of changes in the general price level, all prices in this analysis are expressed in terms of *constant 1985 dollars*. The actual prices selected attempt to reflect projected average prices during the project period. The use of real 1985 dollars is consistent with the use of a real discount rate (see below).

In addition, *relative* prices are assumed not to change over the project life. Quantifying anticipated price changes in any meaningful way is extremely difficult.

The significant *economic life of a project* is the time required such that 90 percent or more of the cumulative present value of the benefits and costs are obtained. For the purposes of this report, the life of the project is assumed to be 30 years, including the project construction period.

Finally, because benefits and costs do not all accrue immediately, future payments must be discounted to their 'present value.' The *discount rate* can be interpreted as the opportunity cost of capital or as a time preference for current as oposed to future consumption. Generally, the higher the discount rate, the less attractive the project. For the purposes of this report, a basic real discount rate of seven percent per annum is employed.

4.4 Provincial Analysis

Base Case

The empirical results are summarized in accompanying Table 4.1. The economic B/C ratio is about .60 for all four of the reservoir sites here considered while the socio-economic B/C ratio (which considers the "spin-offs" from agriculture) is about 1.10.

These results, therefore, essentially preclude a ranking of the respective sites solely on the basis of their potential for irrigation. Since the anticipated benefits are very similar irrespective of which site is selected while unit costs are also very similar, the sites appear almost identical from a purely economic perspective.

This is especially true when it is realized that virtually all benefit-cost ratios can realistically error by as much as *20 percent.*[1]

Because the simulations are restricted to the anticipated impacts on agriculture, the *absolute* value of the respective B/C ratios is also difficult to interpret. Fundamentally, a value of 0.60 simply means that over 30 years the net agricultural benefits in $ 1985 would probably amount to about 60% of initial development costs. Or, with reference to a socio-economic B/C ratio of 1.1, this would essentially mean that if we also considered agricultural "spin-offs" over 30 years (again in $ 1985), the proposed development should at least break even.

---

[1]United Nations, *Guide to Practical Project Appraisal*, UNIDO, New York, 1978.

Table 4.1

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC BENEFIT-COST RATIOS FOR AGRICULTURE*
WILLOW CREEK BASIN

Reservoir Site	ECONOMIC ANALYSIS		SOCIO-ECONOMIC ANALYSIS**	
	B/C Ratios	NPV ($M 1985)	B/C Ratios	NPV ($M 1985)
1. WC Site #1 (Claresholm-Pulteney)	0.58	(18.5)	1.09	3.8
2. PC Site #2 (Pine Coulee - high)	0.63	(16.7)	1.17	7.8
3. WC Site #2 (Junction - high)	0.59	(21.8)	1.11	5.6
4. WC Site #3 (Lane Creek)	0.58	(19.2)	1.09	4.2

*Total costs versus the net benefits to agriculture.

**Also considers provincial "spin-offs" from agriculture; particularly relevant to satisfy regional development objectives.

Source: Appendix C.

Other anticipated benefits (see Section 3.7) would, however, inflate the B/C ratios calculated in this report. For example, consider the case where non-agricultural net benefits amounted to $2M/annum over the 30 year period. The respective B/C ratios would then be as follows:

Site	Economic B/C	Socio-Economic B/C[1]
WC #1	1.14	2.13
PC #2	1.18	2.21
WC #2	1.06	1.97
WC #3	1.12	2.10

These *composite* B/C ratios would suggest that all of the sites might be an economically feasible proposition (since all B/C ratios exceed 1.0), irrespective of what criteria was used.

But these calculations are just illustrative and further analyses along these lines are not within the terms of reference of the present study. (Appendix A)

In any event, how much confidence can we put in the Base Case analysis, given that virtually all of the anticipated costs, projected benefits and underlying parameters are subject to uncertainty in the future? Sensitivity tests provide insight into this question, as illustrated immediately following.

---

[1]Assuming the "spin-off" from other sectors is similar to that of agriculture, i.e., the multiplier = 1.868.

Sensitivity Tests

Numerous sensitivity tests were performed on the Base Case, as tabulated in Tables 4.2 and 4.3.

These calculations, however, do not help rank the respective sites. What they do indicate is which benefit and cost estimates are more or less critical in the derivation of the respective B/C ratios. This sensitivity to unexpected changes in various benefits or costs can best be expressed in terms of an *elasticity* which is defined as:

$$\ell = \frac{\text{\% Change in B/C Ratio}}{\text{\% Change in a Specific Benefit or Cost}}$$

The larger the elasticity, the more the B/C ratio changes if the value of the variable in question also changes.

These elasticities are as follows:

	Variable	
COSTS:	Reservoir	-.75
	Delivery	-.05
	On-Farm System	-.20
	TOTAL	-1.00
BENEFITS:	Crops	+.36
	Livestock	+.18
	Ag. "Spin-offs"	+.46
	TOTAL	+1.00

For example, if actual reservoir costs unexpectedly climbed 20 percent, then the B/C ratio would probably drop about:

$$20\% \times .75 = 15\%$$

Table 4.2

SENSITIVITY OF SOCIO-ECONOMIC BENEFIT-COST RATIOS
TO CHANGES IN VARIOUS COSTS AND BENEFITS

Variable Change		Alternative Reservoir Sites			
		WC Site #1	PC Site #2	WC Site #2	WC Site #3
BASE CASE B/C RATIO		1.09	1.17	1.11	1.09
Reservior Costs Change	-20%	1.28	1.37	1.30	1.28
	+20%	0.94	1.03	0.96	0.95
Delivery Costs Change	-20%	1.10	1.18	1.12	1.10
	+20%	1.08	1.16	1.10	1.08
On-Farm Irrigation Systems Costs Change	-20%	1.13	1.23	1.15	1.14
	+20%	1.04	1.12	1.06	1.05
Incremental Net Crop Returns Change	-20%	0.94	1.02	0.96	0.95
	+20%	1.23	1.33	1.25	1.24
Incremental Net Livestock Returns Change	-20%	1.01	1.09	1.03	1.02
	+20%	1.16	1.25	1.18	1.17
Indirect Net Ag. "Spin-offs" Change	-20%	0.99	1.07	1.00	0.99
	+20%	1.19	1.28	1.21	1.19
Time Frame is Extended to 50 Years		1.21	1.31	1.24	1.22
Real Discount Rate = 5%		1.28	1.39	1.31	1.29

Table 4.3

SENSITIVITY OF SOCIO-ECONOMIC NET PRESENT VALUES
TO CHANGES IN VARIOUS COSTS AND BENEFITS*
($ Millions 1985)

Variable Change		Alternative Reservoir Sites			
		WC Site #1	PC Site #2	WC Site #2	WC Site #3
BASE CASE NPV		3.8	7.8	5.6	4.2
Reservior Costs Change	-20%	10.5	14.4	13.5	11.2
	+20%	(2.9)	1.3	(2.3)	(2.7)
Delivery Costs Change	-20%	4.2	8.3	6.1	4.6
	+20%	3.4	7.4	5.1	3.8
On-Farm Irrigation Systems Costs Change	-20%	5.6	9.9	7.9	6.2
	+20%	2.0	5.8	3.3	2.3
Incremental Net Crop Returns Change	-20%	(2.5)	0.9	(2.2)	(2.4)
	+20%	10.1	14.8	13.4	10.9
Incremental Net Livestock Returns Change	-20%	0.5	4.3	1.6	0.8
	+20%	7.1	11.4	9.6	7.7
Indirect Net Ag. "Spin-offs" Change	-20%	0.7	2.9	0.1	(0.5)
	+20%	8.3	12.8	11.1	8.9
Time Frame is Extended to 50 Years		9.5	14.5	13.3	10.3
Real Discount Rate = 5%		13.8	19.4	18.3	14.9

*Negative Net Present Values indicated in brackets.

And given a B/C ratio of, say 1.1, this would imply an adjusted B/C ratio of about:

$$1.1 - (1.1 \times .15) = \underline{0.94}$$

And so on for any of the other benefits and costs.

In terms of *discounted* benefits and costs, these elasticities also represent the relative share of both real capital costs and the cumulative real net benefits anticipated over a 30 year period. Thus, the summation of the respective benefit-related elasticities and cost-related elasticities both equal 1.0.

Finally, Table 4.2 indicates how two of the underlying parameters (Section 4.3) also affect the B/C ratio. By truncating the time-frame (to 30 years instead of 50 years) the B/C ratios drop about 10 percent. And, similarly, by employing a real discount rate (interest rate) of 7 percent instead of, say, 5 percent, the B/C ratio drops about 15 percent.

4.5 Regional Analysis

From a regional perspective, local construction expenditures would also represent a very real short-term economic benefit to the area. (Section 3.5)

It is estimated that this provincial "transfer" to the Basin area during construction should amount to approximately the following:

WC Site #1	$2.7 M
PC Site #2	2.7 M
WC Site #2	3.2 M
WC Site #3	2.8 M

This would represent about 9 percent of total capital costs; the remainder would be dissipated across other parts of the province.

Thus, what should be emphasized here is that although construction activity would very obviously inject more money into the local economy for a couple of years, in the longer-run this would be dwarfed by the spinoffs from more intensive agricultural operations and related activity in the Basin. At project maturity, these local spinoffs could amount to about $2 million annually. In turn, local and provincial tax revenues would also increase.

5. FARM FINANCIAL ANALYSIS

5.1 Introduction

A farm financial analysis generally parallels the preceding economic analysis (Section 4) except that (a) all values are taken at market prices, ignoring inflation; (b) taxes are treated as costs and subsidies (and tax credits, etc.) as income; (c) paid wages are a cost; and (d) interest on the repayment of borrowed money is a cost. That is:

	Gross Revenue
less	Cost of Goods and Services
=	Gross Value-Added
less	Depreciation
=	Net Value-Added
plus/less	Subsidies and Taxes
=	Farm Income
less	Real Interest (and Paid Wages)
=	Family Income
less	Return to Family Labor and Management
=	Farm Profits[1]

[1]"Profits" are defined as the return on a farm family's own funds.

Determining the profitability of an agricultural undertaking, however, is a difficult task. Every farm is unique because each has its own unique resource base, product mix, management, capital structure, and location/elevation from Willow Creek.

5.2 Analysis

The proposed irrigation expansion in the Willow Creek Basin would consist exclusively of private farm irrigation systems which would pump directly from the river. At the present time, the demand for water for more irrigated crop production greatly exceeds available supplies. (See Section 1.)

The central questions here are: (1) how can a farmer finance this investment?; and (2) are public funds available to assist in this development?

A general indication of the farm economics of investing in irrigated crop production in the Willow Creek Basin is provided in accompanying Table 5.1.

Given the existing relatively depressed conditions in the agricultural sector, and similar to the purchase of dryland, the initial return to the land, labor, equity capital and management can be expected to be relatively low, almost negligible. During these initial years, farmers with borrowed capital typically "subsidize" this investment and revenues from other income sources such as off-farm employment (beginning farmers) or other on-farm operations (established farmers).

Table 5.1

FARM FINANCIAL ANALYSIS FOR 500 ACRES OF IRRIGATED CROP PRODUCTION
Willow Creek Basin

Year	Delivery/Sprinkler[a]		System O & M[b]		Production Costs[c]	TOTAL COSTS		GROSS REVENUE[d]	Residual[e]	
	Low	High	Low	High		Low	High			
1	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
2	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
3	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
4	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
5	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
6	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
7	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
8	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
9	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
10	40,940	49,790	10,000	12,500	98,000	148,940	160,290	152,500	3,560	-7,79
11-30	-	-	10,000	12,500	98,000	108,000	110,500	152,500	44,500	-7,79
TOTAL (30 years)									$925,600	$762,10
Average/Annum/Acre									$61.71	$50.81

[a] Sprinkler = $367/acre; lost cost delivery = $100/acre and high cost delivery = $200/acre. Net of a $2,200 PFRA grant. Amortized at 12%/annum over 10 years.

[b] O & M costs of $20/acre and $25/acre respectively.

[c] $196/acre. [d] $305/acre. [e] Return to land, labor, equity capital and management.

Eventually, however, without a mandatory repayment to non-equity capital, the net return to the producer climbs. Over 30 years, investing in irrigation facilities ultimately "makes sense". The average net return over this period should amount to four or five times as much as an equal dryland acreage.

Available PFRA grants for individual pumping schemes ($2,200/project) may act as a very modest short-run investment incentive but they have essentially no impact on the long-term profitability of irrigated crop production in the Basin or elsewhere. No other public funds are available.

Table 5.1 may nevertheless underestimate the farmers' ability to pay to the extent that he can take advantage of available income tax credits or lower interest, longer-term financing.[1] These simulations also ignore other inherent advantages to irrigation:

- using before-tax dollars to develop the irrigation system versus after-tax dollars to purchase more dryland;
- greater production stability/less financial risk with irrigation -- almost mandatory with today's high technology and narrow margin agriculture;
- more crop diversity and, hence, more market alternatives, etc.

With irrigation there are simply many more opportunities for good management to excel.

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[1]The Agricultural Development Corporation is now offering longer term credit at a fixed interest rate of 9 percent per annum.

These advantages aside, what are the alternatives and what is the relative payoff to these other farm investment options? This alternative is often the purchase of additional dryland which is an even less profitable option, as illustrated following: ($/acre 1985)

	Irrigation	Dryland
Land Price[1]	$ 525	$525
Delivery System (say)	158	
Sprinkler	367	
	> $525	
Total	$1,050	$525
RATIO	2:1	

At the present time, farm irrigation facilities essentially cost about the same as an equivalent dryland acreage.

Yet this 2:1 investment ratio is totally inconsistent with the relative net returns to the two technologies: (per acre $ 1985)

	Irrigation	Dryland
Gross Revenue	$305	$69
Costs-of-Production	196	50
Net Return	$109	$19
RATIO	5:1	

The appropriate investment ratio should probably be closer to 5:1 rather than the existing 2:1.

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[1]For Willow Creek M.D. #26. See: Alberta Agriculture, *The Alberta Agricultural Real Estate Situation*, Edmonton, quarterly reports, 1985.

This underlying inconsistency can generally be traced to an inflated market price for dryland. In terms of its agricultural productivity, dryland is presently over-valued.[1] At a price for dryland of, say, $250/acre, the comparative advantage of irrigation would not be as self-evident.

In any event, the long term trend in agriculture towards more intensive, high-technology production would generally suggest that it is unlikely that the long-run demand for water for additional irrigation in the Willow Creek Basin will diminish. Indeed, it is much more likely that this demand will increase, perhaps exponentually and probably indefinitely.

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[1]A good rule-of-thumb is that land should sell for approximately ten times land rentals. The present over-valuation of dryland is typical in most areas of the province and elsewhere.

6. SUMMARY AND CONCLUSIONS

6.1 Summary

The overall objective of this study was to determine the *economic* and *financial* feasibility of developing additional storage to augment water supplies for irrigated agriculture in the Willow Creek Basin.

The four potential reservoir sites are:

1. Willow Creek Site #1 (Claresholm-Pulteney)
2. Pine Coulee Site #2 - High (offstream)
3. Willow Creek Site #2 - High (Junction)
4. Willow Creek Site #3 (Lane Creek/Kuntz Creek)

The study focuses exclusively on the anticipated benefits and costs to agriculture.

The basic methodology utilized is discounted cash flow analysis, a methodology which traces all the tangible incremental costs and benefits of a project over time, adjusts future dollars to the present (by using the inverse of an interest rate), and then compares the cumulative value of the projected benefit stream with the cumulative value of the anticipated cost stream.

To be economically or financially feasible, the Benefit-Cost Ratio (B/C) must exceed 1.0, and the Net Present Value (NPV) must be positive.

This assessment is conducted from three different accounting stances: farmers, the region, and the province.

From a provincial perspective, the basic empirical results are provided in accompanying Table 6.1. The economic B/C ratio is about .60 for all four potential reservoir sites while the socio-economic B/C ratio (which considers the "spin-offs" from agriculture) is about 1.10.

These results, therefore, essentially preclude a ranking of the respective sites solely on the basis of their potential for irrigation. Since the anticipated benefits are very similar irrespective of which site is selected while unit costs are also very similar, the sites appear almost identical from a purely economic perspective.

This is especially true when it is realized that virtually all benefit-cost ratios can realistically error by as much as *20 percent.*[1]

Because the simulations are restricted to the anticipated impacts on agriculture, the *absolute* values of the respective B/C ratios is also difficult to interpret. Fundamentally, a value of, say, 0.60 simply means that over 30 years the net agricultural benefits in $ 1985 would probably amount to about 60 percent of initial and on-going development costs. Or, with reference to a socio-economic B/C ratio of, say 1.1, this would essentially mean that if we also considered agricultural "spin-offs" over 30 years (again in $ 1985), the proposed development should at least break even.

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[1]United Nations, *Guide to Practical Project Appraisal*, UNIDO, New York, 1978.

Table 6.1

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC BENEFIT-COST RATIOS FOR AGRICULTURE*
WILLOW CREEK BASIN

Reservoir Site	ECONOMIC ANALYSIS		SOCIO-ECONOMIC ANALYSIS**	
	B/C Ratios	NPV ($M)	B/C Ratios	NPV ($M)
1. WC Site #1 (Claresholm-Pulteney)	0.58	(18.5)	1.09	3.8
2. PC Site #2 (Pine Coulee - high)	0.63	(16.7)	1.17	7.8
3. WC Site #2 (Junction - high)	0.59	(21.8)	1.11	5.6
4. WC Site #3 (Lane Creek)	0.58	(19.2)	1.09	4.2

*Total costs versus the net benefits to agriculture.

**Also considers provincial "spin-offs" from agriculture; particularly relevant to satisfy regional development objectives.

Other anticipated benefits would, however, inflate the B/C ratios calculated in this report. If the direct non-agricultural net benefits actually averaged some $2M/annum over a 30 year period, even the purely economic benefit-cost ratios would exceed unity.

From a regional perspective, short-term construction expenditures would also have a generally positive economic impact on local communities; an income injection of about $3M for any one of the reservoirs here considered over a two year period. But in the longer-term, this would be dwarfed by the spin-offs from more intensive agricultural operations and related activity in the Basin.

Finally, a brief assessment of the financial implications of on-farm irrigation development in the Basin illustrates how this is largely dependent upon a farmers' particular circumstances. In addition, narrow short-term margins emphasize why this investment would have to be considered a long-term investment in a non-depreciating capital resource. In part, however, this simply mirrors the depressed conditions which presently plague the entire agricultural industry. Even in this context, irrigated agriculture has a comparative advantage over dryland agriculture.

6.2 Conclusions

The principal conclusions of this study are:

1. The net return to irrigation development in the Willow Creek Basin would be very similar irrespective of which proposed reservoir site was selected. By only utilizing economic efficiency criteria (and acknowledging the margin of error inherent in the analysis), therefore, it is not possible to

definitively rank the respective reservoirs in terms of their economic feasibility. From a provincial viewpoint, we can only conclude that if only the potential net benefits to agriculture are considered, all four proposed reservoirs appear to be equally poor investment opportunities.

2. From a purely economic perspective, therefore, it is estimated that non-agricultural benefits of $1½ M/annum to $2 M/annum would be required to justify any further reservoir construction in the Basin.

3. On the other hand, from a socio-economic perspective (which considers the spinoffs from proposed irrigation development), all of the proposed reservoirs appear to be viable investment opportunities irrespective of any net benefits to the province other than those generated by agriculture-related activities. Furthermore, if this rationale was valid, we would also tentatively conclude that the offstream Pine Coulee Site would most likely generate the largest total long-term net benefit to the province.

APPENDIX

APPENDIX A

TERMS OF REFERENCE

Using appropriate methodologies and analytical techniques, the consultant will undertake an economic analysis of proposed water storage projects in the Willow Creek Basin. The analysis will be from a provincial perspective and will include primary and secondary net benefit determination and the distribution of benefits and costs.

Four alternative sites are to be considered.

A. For each alternative that is being considered, the consultant will:

1. Indicate the additional area and location of land in the Basin that could be irrigated if additional storage was provided.

2. Estimate the increased gross and net revenue to farmers because of a change from dryland to irrigation farming.

3. Increase the capital and operating costs that would be associated with providing storage for irrigation.

4. Identify and, if possible, quantify any secondary costs and benefits which would be expected if the project was implemented.

5. Determine the economic feasibility of the alternative.

B. The alternatives will be ranked in terms of their economic feasibility.

C. Sensitivity analysis will be undertaken for those variables having the greatest degree of uncertainty.

D. Estimate the possible impact of P.F.R.A. assistance programs:

I) from a farm financial perspective

II) from the point of view of distribution of costs and benefits.

APPENDIX B

BACKGROUND DATA FOR FARM BUDGETS

Table B-1

CROP MIX, YIELDS, PRICES AND CROP REVENUE WITH IRRIGATION IN THE WILLOW CREEK BASIN, 1985-86

Land Use	Area[a] (100 acres)	Yields[b] per Acre	Prices[c]		TOTAL REVENUE PER 100 ACRES	
			Financial	Economic	Financial	Economic
Wheat (especially soft white)	25	75	3.17	3.74	5,944	7,013
Barley[d]	10	80	2.16	2.61	1,728	2,088
Canola/Other Oilseeds	5	40	6.57	7.46	1,314	1,492
Hay/Alfalfa[e]	45	4.0	76.16	62.11	13,709	11,180
Barley/Oat Silage (90% D.M.)[f]	10	6.7	49.00	61.00	3,283	4,087
Other ("Specialty")	5	-	-	-	4,535	6,250
TOTAL	100%				30,513	32,110
WEIGHTED AVERAGE/ACRE					305	321
(per hectare)					(753)	(793)

[a] For rationale, see text.

[b] Yields generally taken from: Alberta Agriculture, *Irrigation Water Requirements in the South Saskatchewan River Basin: Economic Component*, Resource Economics Branch, Edmonton, February 1983. (Agroclimatic Zone C.) All yields based on a water application rate of 36.6 cm (144"). Grain and oilseed yields expressed in bushels/acre; forage yields provided in (metric) tonnes per acre.

[c] Financial prices = 90.7% of 1984 prices; consistent with the decline in the Index of Ag. Farm Product Prices for Alberta in 1985. Economic prices = average 1972-84 prices, expressed in terms of $ 1985. Deflated by the Agricultural Product Price Index (Alberta) where September 1985 = 100.0.

[d] Sometimes good quality barley can be sold for a premium of approximately $1.00/bushel.

[e] Good quality hay/alfalfa can sometimes be sold to neighboring dairies for a premium of approximately $10/tonne.

[f] Yields and prices tied to barley grain. Estimated by local beef feedlot operators.

Table B-2

COSTS OF PRODUCTION FOR IRRIGATED CROPS IN THE WILLOW CREEK BASIN, 1985-86
(per acre)

ITEM / CROP	Seed	Fertilizer	Chemicals	Taxes	Insurance	Machinery Operation and Repairs[a]		Miscellaneous Overhead		Interest on Operating Capital	SUB-TOTAL	Depreciation		TOTAL
						Fuel	Repair	Buildings	Other			Buildings	Machinery	
Wheat	9.37	48.70	17.05	3.00	6.00	23.80	20.48	1.89	15.41	7.75	153.45	6.13	44.12	203.70
Barley	5.71	42.34	17.93	3.00	6.00	24.04	19.68	1.89	14.63	7.36	142.58	6.96	42.39	191.93
Canola/Other	4.21	67.21	24.93	3.00	6.00	22.59	19.25	1.89	14.64	8.42	172.14	3.00	41.45	216.59
Hay/Alfalfa	5.00	30.16	-	3.00	-	22.59	17.00	1.89	13.75	3.82	97.21	3.00	36.61	136.82
Barley/Oat Silage	5.71	42.34	17.93	3.00	6.00	24.04	19.68	1.89	14.63	7.36	142.58	6.96	42.39	191.93
Other ("Specialty")[b]	47.28	118.22	76.07	3.00	6.00	79.72	62.85	1.89	46.67	30.29	571.99	3.00	110.35	685.34
WEIGHTED AVERAGE/ACRE	8.31	43.49	17.90	3.00	3.30	26.04	20.81	1.89	16.03	7.06	147.83	4.57	43.57	195.97
(per hectare)														(484.05)

[a] Excluding O & M Costs for the center pivot.

[b] Based on historical data for CD #3.

Basic Sources: Reconciled from data available from Statistics Canada (Census of Ag., 1981), Alberta Treasury (provincial accounts), and Alberta Agriculture (Ag. Stats. and CRD's). Cereal seed and fertilizer costs adjusted downward 30% and 20%, respectively. Taxes and insurance costs based on local farmer estimates.

Table B-3

AVERAGE CROP MIX, YIELDS, PRICES AND CROP REVENUE WITH DRYLAND
IN THE WILLOW CREEK BASIN, 1985-86

Land Use	Area[a] (100 acres)	Yields[b] per Acre	Prices[c] Financial	Prices[c] Economic	TOTAL REVENUE PER 100 ACRES Financial	TOTAL REVENUE PER 100 ACRES Economic
IMPROVED						
Wheat (includes durum and winter wheat)	25	25	3.96	4.68	2,475	2,925
Barley	35	40	2.16	2.61	3,024	3,654
Oats	3	55	1.29	1.62	213	267
Oilseeds (Canola)	2	17	6.57	7.46	223	254
Hay	10	1.1	76.16	62.11	838	683
Improved Pasture	5	1.02 AUM	11.39	9.40	58	48
Summerfallow	10		-	-		
UNIMPROVED	10	.35 AUM	11.39	9.40	40	33
TOTAL	100				6,871	7,864
WEIGHTED AVERAGE/ACRE					$69	$79
(per hectare)					($170)	($195)

[a] For rationale, see text.

[b] Projected 1985 yields based on a linear trend line for the period 1974-83, net of irrigation. For the basic data, see Alberta Agriculture, *Agricultural Statistics Yearbook*, Edmonton, various years. Grain and oilseed yields expressed in bushels/acre; all other yields provided in (metric) tonnes per acre. AUM = animal unit month.

[c] Financial prices = 90% of 1984 prices; consistent with the decline in the Index of Ag. Farm Product Prices for Alberta in 1985. Economic prices = average 1972-84 prices, expressed in terms of $ 1985. Deflated by the Agricultural Product Price Index (Alberta) where September 1985 = 100.0. Pasture prices = private grazing rates = 1.53 x public grazing reserve rates.

Table B-4

COSTS OF PRODUCTION FOR DRYLAND CROPS IN THE WILLOW CREEK BASIN, 1985-86
(per acre)

ITEM / CROP	Seed	Fertilizer	Chemical	Crop Insurance	Taxes	Machinery Operation and Repairs		Miscellaneous Overhead		Interest on Operating Capital	SUB-TOTAL	Depreciation		TOTAL
						Fuel	Repairs	Buildings	Other			Buildings	Machinery	
Wheat	6.50	10.38	6.00	4.00	2.00	7.22	5.74	.67	4.18	1.47	48.11	2.14	16.69	66.94
Barley	5.33	11.20	6.00	4.00	2.00	7.38	6.20	.67	4.24	1.47	48.49	2.99	17.53	69.01
Oats	3.72	8.31	6.00	4.00	2.00	6.86	5.91	.67	3.75	1.27	42.49	4.17	18.02	64.68
Oilseeds (Canola)	3.66	12.35	8.00	4.00	2.00	6.78	5.51	.67	4.66	1.63	49.26	2.10	16.35	67.71
Hay	.27	2.82	-	-	2.00	5.27	4.58	.67	1.91	.49	18.01	1.07	13.85	32.93
Improved Pasture	-	1.44	-	-	2.00	-	-	.67	.29	.09	4.49	1.07	-	5.56
Summerfallow	-	-	-	-	2.00	3.32	2.81	.67	.91	.20	9.91	1.07	6.18	17.16
UNIMPROVED	-	-	-	-	2.00	-	-	-	-	-	2.00	-	-	2.00
WEIGHTED AVERAGE/ACRE	3.70	7.37	3.94	2.60	2.00	5.59	4.63	.60	3.03	1.01	34.47	2.02	13.18	49.67
(per hectare)														(122.69

Basic Sources: Initially reconciled from data available from Statistics Canada (Census of Ag., 1981), Alberta Treasury (provincial accounts), and Alberta Agriculture (Ag. Stats. and CRD's). Subsequently adjusted by reducing seed and fertilizer costs 30% and 20% respectfully and machinery O & M by 25%. Interest costs = 6% of fertilizer, chemical and fuel costs. Taxes insurance costs, and chemical costs based on local farmer estimates. Also see: Alberta Agriculture, *Crop Enterprise Analysis: Vulcan-Champion District*, December 6, 1985.

APPENDIX C

SIMULATIONS

Table C-1

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - WILLOW CREEK SITE #1 (Claresholm-Pulteney)**
WILLOW CREEK BASIN
($000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net Indirect	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock		$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	12,000	-	-	-	-	-	12,000	11,215	-	-	-	-	-	-	-
2	-	18,000	-	-	-	-	-	18,000	15,721	-	-	-	-	-	-	-
3	7,500	-	600	430	-	2,753	163	3,946	3,221	728	375	957	1,103	900	2,060	1,682
4	10,000	-	600	408	-	918	223	2,149	1,639	970	500	1,276	1,470	1,121	2,746	2,095
5	12,500	-	600	438	-	918	283	2,239	1,596	1,213	625	1,595	1,838	1,310	3,433	2,448
6	15,000	-	600	463	-	918	344	2,325	1,549	1,455	750	1,914	2,205	1,469	4,119	2,744
7	17,500	-	600	563	-	918	409	2,490	1,551	1,698	875	2,233	2,573	1,602	4,806	2,993
8	18,700	-	600	270	-	440	440	1,750	1,019	1,814	935	2,386	2,749	1,600	5,135	2,989
9-30	18,700	-	600	-	-	-	440	1,040	6,695	1,814	935	2,386	2,749	17,697	5,135	33,057
PRESENT VALUE*									44,206(C)					25,699(B)		48,008(B')

*Real discount rate = 7% per annum.

**Capacity = 32,400 acre-feet.
Effective storage = 28,000 acre-feet.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	0.58	1.09
Net Present Value = B-C =	($18.5M)	$3.8M

Table C-2

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - PINE COULEE SITE #2 (HIGH)**
WILLOW CREEK BASIN
($000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock	Indirect	$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	11,800	-	-	-	-	-	11,800	11,028	-	-	-	-	-	-	-
2	-	17,700	-	-	-	-	-	17,700	15,459	-	-	-	-	-	-	-
3	7,500	-	590	430	-	2,753	163	3,936	3,213	728	375	957	1,103	900	2,060	1,682
4	10,000	-	590	408	-	918	223	2,139	1,632	970	500	1,276	1,470	1,121	2,746	2,095
5	12,500	-	590	438	-	918	283	2,229	1,589	1,213	625	1,595	1,838	1,310	3,433	2,448
6	15,000	-	590	463	-	918	344	2,315	1,542	1,455	750	1,914	2,205	1,469	4,119	2,744
7	17,500	-	590	563	-	918	409	2,480	1,544	1,698	875	2,233	2,573	1,602	4,806	2,992
8	20,000	-	590	563	-	918	474	2,545	1,481	1,940	1,000	2,552	2,940	1,711	5,492	3,196
9	21,300	-	590	293	-	477	507	1,867	1,015	2,066	1,065	2,718	3,131	1,703	5,849	3,181
10-30	21,300	-	590	-	-	-	507	1,097	6,465	2,066	1,065	2,718	3,131	18,453	5,849	34,472
PRESENT VALUE*									44,968(C)					28,269(B)		52,810(B')

*Real discount rate = 7% per annum.

**Off-stream reservoir. Capacity = 41,000 acre-feet.
Effective storage = 32,000 acre-feet.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	0.63	1.17
Net Present VAlue = B-C =	($16.7M)	$7.8M

Table C-3

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - WILLOW CREEK SITE #2 - HIGH (JUNCTION)**
WILLOW CREEK BASIN
($000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock	Indirect	$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	14,200	-	-	-	-	-	14,200	13,271	-	-	-	-	-	-	-
2	-	21,300	-	-	-	-	-	21,300	18,603	-	-	-	-	-	-	-
3	7,500	-	710	430	-	2,753	163	4,056	3,311	728	375	957	1,103	900	2,060	1,682
4	10,000	-	710	408	-	918	223	2,259	1,723	970	500	1,276	1,470	1,121	2,746	2,095
5	12,500	-	710	438	-	918	283	2,349	1,675	1,213	625	1,595	1,838	1,310	3,433	2,448
6	15,000	-	710	463	-	918	344	2,435	1,622	1,455	750	1,914	2,205	1,469	4,119	2,744
7	17,500	-	710	563	-	918	409	2,600	1,619	1,698	875	2,233	2,573	1,602	4,806	2,992
8	20,000	-	710	563	-	918	474	2,665	1,551	1,940	1,000	2,552	2,940	1,711	5,492	3,196
9	22,500	-	710	563	-	918	539	2,730	1,485	2,183	1,125	2,871	3,308	1,799	6,179	3,361
10	25,000	-	710	563	-	918	604	2,795	1,421	2,425	1,250	3,190	3,675	1,868	6,865	3,489
11-30	25,000	-	710	-	-	-	604	1,314	7,076	2,425	1,250	3,190	3,675	19,791	6,865	36,970
PRESENT VALUE*									53,357(C)					31,571(B)		58,977(B')

*Real discount rate = 7% per annum.

**Capacity = 59,200 acre-feet.
Effective Storage = 37,500 acre-feet.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	0.59	1.11
Net Present Value = B-C =	($21.8M)	$5.6M

Table C-4

PROVINCIAL ECONOMIC AND SOCIO-ECONOMIC ANALYSIS - WILLOW CREEK SITE #3 (LANE CREEK-KUNTZ CREEK)**
WILLOW CREEK BASIN
($000 1985)

		INCREMENTAL COSTS								INCREMENTAL BENEFITS						
		Reservoir		Delivery		On-Farm		TOTAL		Net Direct On-Farm		Net	TOTAL ECONOMIC		TOTAL SOCIO-ECONOMIC	
Year	Area (acres)	Capital	O & M	Capital	O & M	Capital	O & M	$ 85	Discounted*	Crops	Livestock	Indirect	$ 85	Discounted*	$ 85	Discounted*
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1	-	12,500	-	-	-	-	-	12,500	11,683	-	-	-	-	-	-	-
2	-	18,750	-	-	-	-	-	18,750	16,376	-	-	-	-	-	-	-
3	7,500	-	625	430	-	2,753	163	3,971	3,242	728	375	957	1,103	900	2,060	1,682
4	10,000	-	625	408	-	918	223	2,174	1,659	970	500	1,276	1,470	1,121	2,746	2,095
5	12,500	-	625	438	-	918	283	2,264	1,614	1,213	625	1,595	1,838	1,310	3,433	2,448
6	15,000	-	625	463	-	918	344	2,350	1,566	1,455	750	1,914	2,205	1,469	4,119	2,744
7	17,500	-	625	563	-	918	409	2,515	1,566	1,698	875	2,233	2,573	1,602	4,806	2,992
8	20,000	-	625	563	-	918	474	2,580	1,502	1,940	1,000	2,552	2,940	1,711	5,492	3,196
9-30	20,000	-	625	-	-	-	474	1,099	7,075	1,940	1,000	2,552	2,940	18,926	5,492	35,355
PRESENT VALUE*									46,283(C)					27,039(B)		50,512(B')

*Real discount rate = 7% per annum.

**Capacity = 47,800 acre-feet.
Effective Storage = 30,000 acre-feet.

	Economic	Socio-Economic
Benefit-Cost Ratio = B/C =	0.58	1.09
Net Present Value = B-C =	($19.2M)	$4.2M

APPENDIX D

AGRICULTURAL CENSUS PROFILE

APPENDIX D

AGRICULTURAL PROFILE, 1980-81*
WILLOW CREEK M.D. #26

Number of Farms	820
Farm Population	2,970
Average Acre/Farm	1,345 acres

Crops	40%
Pasture	9%
Summerfallow	10%
Other Improved	1%
Unimproved	40%

Crops:

Spring Wheat	23%	Rye	4
Durum Wheat	7	Flax	1
Utility Wheat	-	Canola	2
Winter Wheat	5	Mustard	-
Oats	4	Hay	13
Barley	35	Oat/Other Fodder	4
		Other	2

Livestock Numbers:

Cattle and calves	128,099
Cattle on feed	23,542
Hogs	27,191
Poultry (chicken)	142,316

Farm Types:

Dairy	3%	Wheat	19
Cattle	38	Small Grains	29
Hogs	3	Other Crops	1
Poultry	1	Mixed	3
		Miscellaneous	3

continued...

Farm Revenue:(#)

< $10,000	124
$10 - $50,000	307
$50 - $100,000	181
$100 - $250,000	143
> $250,000	65
Average	$100,844

Hired Labor:

Number of Farms	38%
Average for all Farms	19.4 weeks/year

Average Farm Capital:

Total	$1,084,008
Land and Buildings	899,800**
Machinery	93,384
Livestock	90,824

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*Includes both dryland and irrigation. Errors due to rounding.

**Land value 90 percent of the total value.

Source: Statistics Canada, *Census of Agriculture, Alberta, 1981*, Ottawa, 1982.

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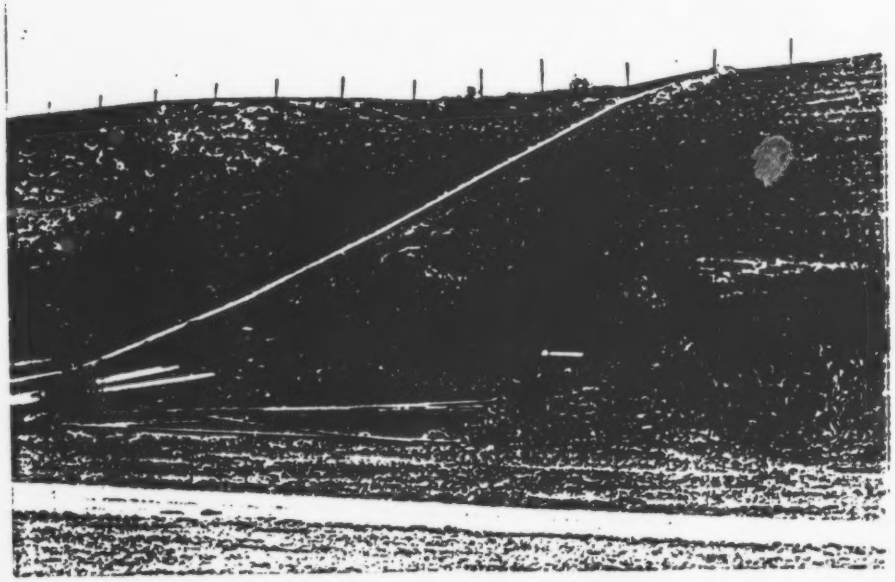
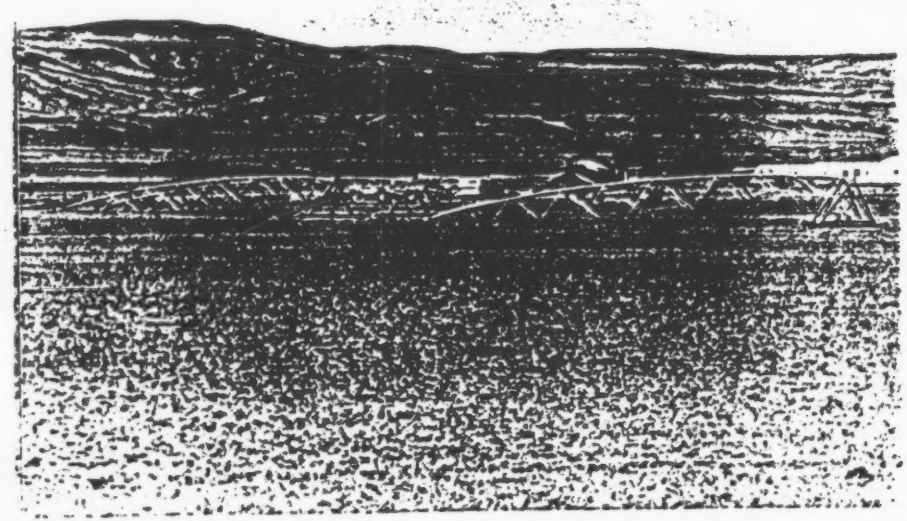
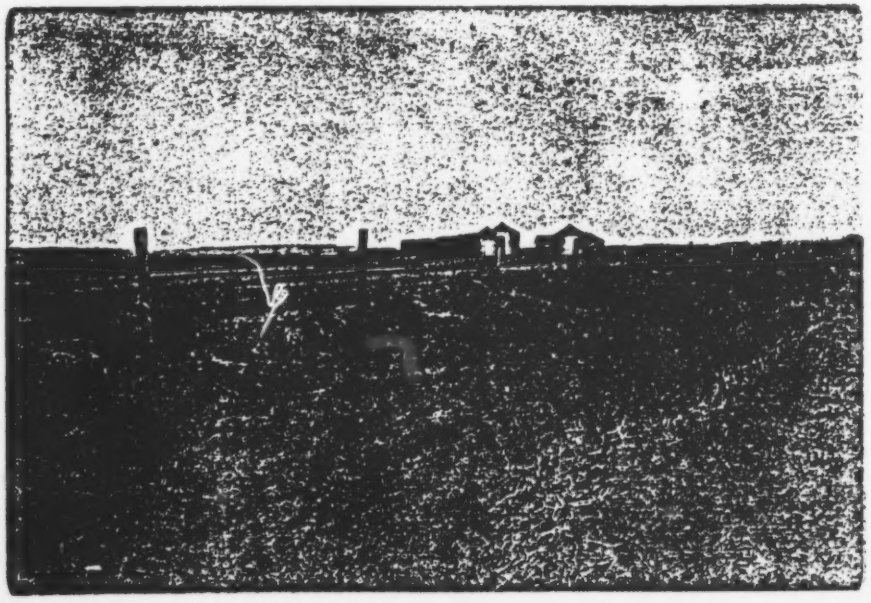


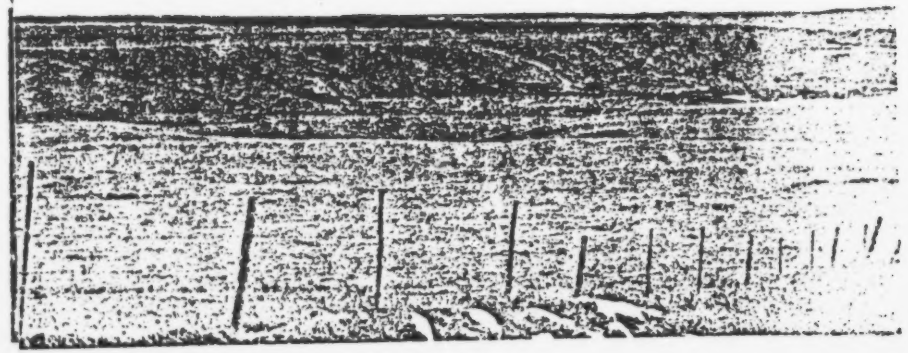
Mainline from Willow Creek to existing whell roll system



Installation of a new center pivot in the Willow Creek Basin



Wind erosion on existing dryland



Pine Coulee looking south at potential damsite